Chapter 4
Towards a Database for an Information Management System on Climate Change: An Online Resource

V. Ramani Bai, S. Mohan and Reza Kabiri

Abstract The aim of the research study is to develop a resourceful database information and management system (DIMS) for climate change and coastal degradation. An important element of the DIMS is to have a coastal resource. This usually requires a great deal of data, and an information system can provide tremendous assistance in organizing, managing, understanding and reporting this information. Together, relational databases and geographical information systems (GIS) provide powerful tools for organizing and analysing environmental data. The climate change coastal resource information system has been designed to be simple, yet flexible. The database structure allows for variation in the level of detail provided for each variable and country. In addition to the ability to view, query and report monitoring data, the DMIS also allows users to display the data spatially using a GIS.

Keywords Database · Climate change · Coastal climate · Geographical information system · Metadata · Geodata · Meteorology

Introduction

Climate change data encompasses a very large array of data objects, with many available in a variety of data formats. It is important to make a database management system (DBMS) such that one can project and model the climate

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change parameters (Liu et al. 2009). This paper emphasizes the essential need for a total approach to climate change data management, particularly through the development and application of scenarios at the scale of regions to assess the response of natural (land and water) systems at the local level. The climate change data management initiative is the result of a link between ESRI (2002) and the climate change sciences community regarding climate change data representation and analysis challenges. Collaboration towards a development, using the common data model, helps to address the needs of the climate change community, and provides direction for ESRI software and tool development (Barnolas and Llasat 2007).

The ultimate goal of an ArcGIS climate change data management and model is to represent each of these data objects in a uniform manner, allowing their integrated analysis in the ArcGIS desktop environment. Some of the data considered in the climate change study includes:

1. Map backgrounds, geopolitical boundaries
2. Climatology and meteorology (rainfall, temperature, humidity, solar radiation, wind speed, wind direction, etc.)
3. Oceanographic observations and products (surface and deep)
4. Geological observations and products
5. Sociological (land use, population, etc.)
6. Surface properties (soils, soil moisture, etc.)
7. Biological observations and products (vegetation cover, agricultural production, etc.)
8. Space environment (STP, solar activity, magnetic fields, etc.)
9. Hydrology
10. Sub-surface water

- Emission inventories (EPA, etc.)

11. Emergency management criteria, constraints

Problem Definition

This paper emphasizes the essential need for a total approach to climate change data management, particularly through the development and application of scenarios at the scale of regions to assess the response of land and water systems at the local level and their policy issues. Physical changes are implicated in the functioning of our regional climate. In addition, the biophysical and ecological functions of our environments also experience the impacts of climate change. Scientific evidence is increasingly indicating that environmental changes are occurring at all scales, as a result of climate change and climate variability. The research focuses on database management systems such as geographic distribution, the impact of climate change, etc.

Goals and Objectives

The concept is aimed for use by environmental sectors and for reporting to environmental authorities. The focus is on environmental data relevant to the state of climate change in the world. The objectives of this paper include:

a. Development of an integrated database management,
b. Share determination of the different ecosystems in environmental categories (global warming, Ozone depletion, etc.) in climate change study,
c. Environmental promotion of sensitive ecosystem and sustainable development, human health and improvement by database management,
d. Improvement of inventory and climate model.

Materials and Methods

This trend has been further developed with the progressive evolution and widespread use of the Internet and World Wide Web (WWW): with the expansion of Geographical Information Systems (GIS) onto the Internet, access to geographic data, and the manipulation of it, will become even easier for the environmental manager who may not necessarily be a computer applications specialist or scientist. The importance of being able to share scientific data has received increasing attention in the last few years from many researchers. Şahin and Kurum (2002) analysed by GIS the areas with higher landscape value in the impact assessment of dam constructions in the Seyhan-Köprû Hydroelectric Dam project proposal. The studies assessed the GIS tools and found them to be crucial for impact assessment and predicted that usage will dramatically increase in the near future.

A considerable amount of time and effort has already been directed towards the development of data models, data formats and spatial data infrastructures (SDI) to help overcome the problems associated with data sharing. Efficient implementation and monitoring of environmental measures related to climate change requires interoperable spatial information across national borders.

To effectively implement a GIS using the geodatabase, a solid database design and development must be put in place. In the GIS, the geodatabase provides a framework for geographic information and supports topologically integrated feature classes (Barnolas and Llasat 2007). Figures 1 and 2 refer to the methodology of development of the database system through this research.

The conceptual design illustrates the database organization and structure in tables and Unified Modelling Language (UML) diagrams that define the features and geographic representation of the required ArcInfo datasets and relationships. It also shows the user's view of the data within a database environment. This step basically involves the actual creation of the geodatabase tables from the abstract features defined in the study that is a skeleton of the final geodatabase. NIWA (2009) web information is also captured for database related to lakes, aquaculture and many other recent information on environment.

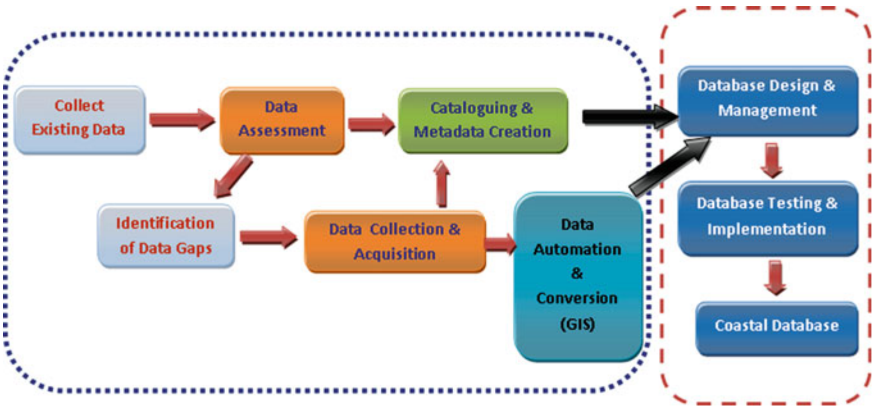

Fig. 1 Methodology of new database information management system

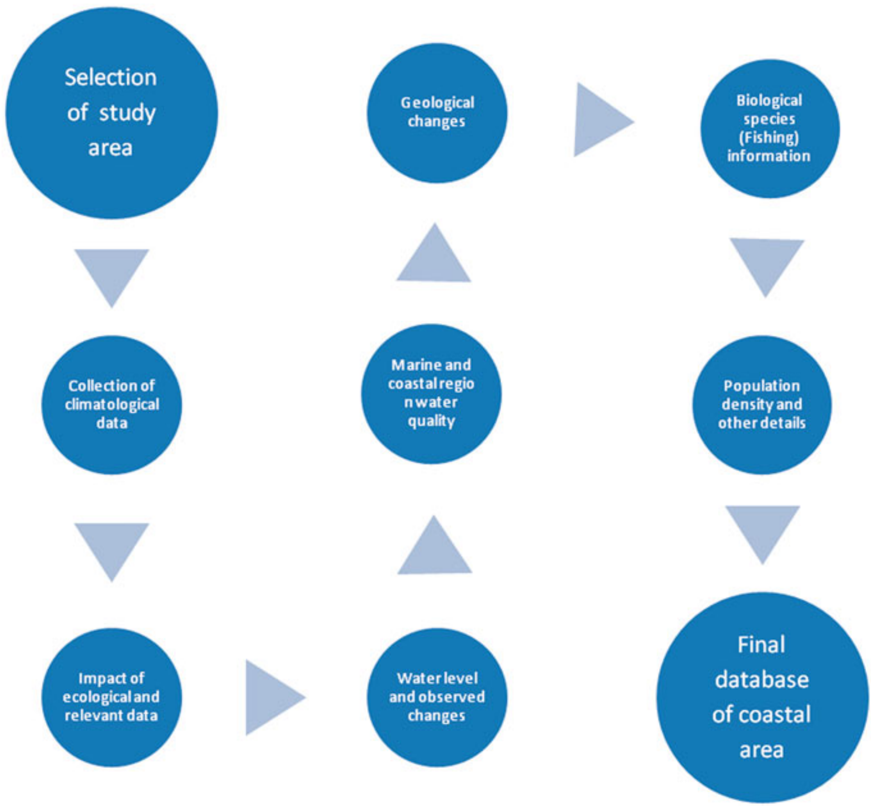

Fig. 2 Task flow in database system

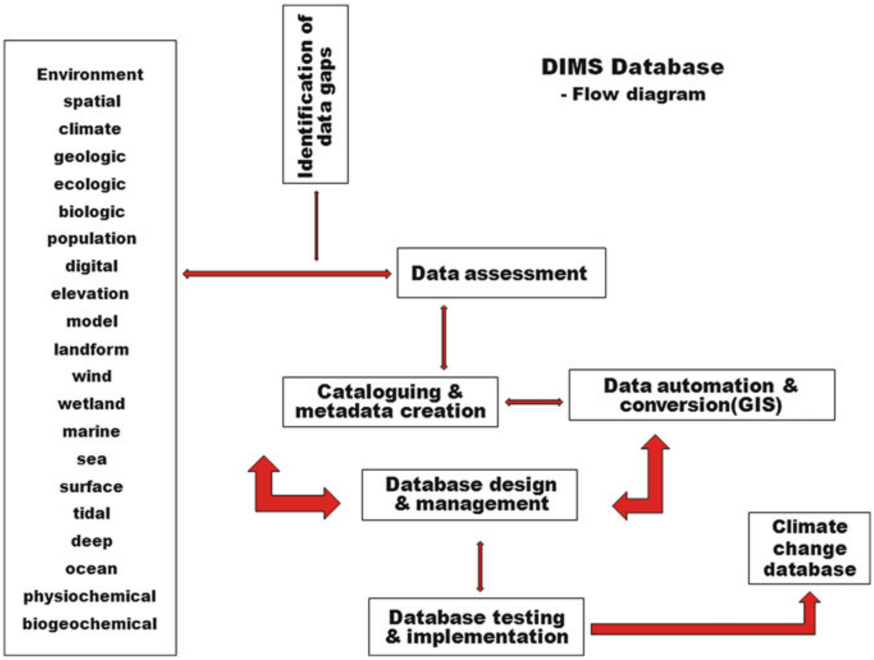

Fig. 3 GIS workflow diagram in DIMS

Metadata is a standard part of any GIS and is not an extension of functionality. The tools for creating and managing metadata are key technologies for sharing geographic information and building communities. This tool is in the core of ArcGIS software. Metadata makes spatial information more useful to all types of users by making it easier to document and locate data sets (Wilhelmi et al. 2005). It is a summary document providing content, quality, type, creation, and spatial information about a data set. It can be stored in any format such as a text file, Extensible Markup Language (XML), or database record. Because of its small size compared to the data it describes, metadata is more easily shareable. By creating metadata and sharing it with others, information about existing data becomes readily available to anyone seeking it. Metadata makes data discovery easier and reduces data duplication.

Next, design and implementation of a data-driven website and relational database consisting of climatic, geologic, ecologic, biologic (both quality and quantity) information, and spatial data will be done with GIS tools, as well as greenhouse gas (GHG) emissions and global warming to predictions of local impacts and system feedbacks (Liu 2009; Baker 2009). For proper development and use of the geodatabase, an accompanying data management plan will be developed. It will review important issues the environment must address such as the server configuration, user access, security, workflow and data location. The flow of work in creation of database information and management system (DIMS) is shown in Fig. 3.

Once the conceptual and logical geodatabase are developed, any of three methods below can be used to create the physical geodatabase:

- Migrating existing coverage/shapefile data into the geodatabase
- Creating a new geodatabase from scratch using ArcCatalog
- UML and computer-aided software

ArcGIS software uses the XML standard for metadata processing. Every feature dataset, feature class and attributes will be defined and created in this template, so the actual data layers can be placed into the geodatabase. In the GIS, the geodatabase provides a framework for geographic information and supports topologically integrated feature classes.

These data sets are stored, analysed and queried as layers similar to the coverage and shapefile models (Zeiler 1999). The system is based on web-based client–server architecture. The content management system will be handled by Joomla and application customization will be carried out using PHP to implement searchable interfaces. The web mapping server handles the linkage between spatial objects and non-spatial attribute data stored in a relational database. The web-based system will allow the users to interactively query, visualize data and analyse spatially through decision support tools.

Conclusion

From the layers used in climate change study, we derive a more comprehensive list of elements that are used to help analysis. It is here that we add attributes to features. This helps to determine which objects will be represented as points, lines and polygons, and also in the form of raster and tables. The approach provides a constant flow for the exchange of ideas, data and methods that works towards an end result that works in a GIS. In recent years, we have acquired more sources of information, including newspapers, showing some ordinary climate change that in the past could have gone unnoticed. This geodatabase will be created. Besides its wide geographic coverage, the climate change geodatabase also offers the advantage of containing updated information up to years included in scenarios. It is very important to have the information updated to the model.

In order to store, manage and analyse all the information available, a relational structure should be chosen. This geodatabase will be implemented on a GIS. It is a more efficient way to store information and to analyse it. In this way, it can be a helpful tool aimed at improving climate change assessment in addition to vulnerability information and others.

Supporting Information Available

Detailed set of database, products, events, key partners and other useful information are available on the Internet for public use. The materials are currently available on request at www.globalclimate-engine.org and will be provided free of charge once proper legal and policy matters are settled by end of the project period, which is June 2011.

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